Agenda

- Opening remarks – David Nemtzow
- Impact of energy on default risk in commercial mortgages (~25 mins)
  - Paul Mathew, Lawrence Berkeley National Laboratory
  - Nancy Wallace, UC Berkeley Haas School of Business
- Appraising green buildings (~15 mins)
  - Andrew White, JDM Associates
- Discussion (~30 mins)
Energy and default risk in commercial mortgages

Paul Mathew
Nancy Wallace

Lawrence Berkeley National Lab
University of California, Berkeley
What about commercial mortgages?

Commercial mortgages currently do not fully account for energy factors in underwriting and valuation…

…energy efficiency is not properly valued and energy risks are not properly assessed and mitigated.

Commercial mortgages are a large lever and could be a significant channel for scaling energy efficiency.
The link between energy and valuation

Energy directly affects Net Operating Income (NOI) used in valuation.

- **Energy Use Volume**
  - Electricity kWh/kW, fuel therms, etc.
  - Driven by bldg. features, operations, climate

- **Energy Use Volatility**
  - +/- change over mortgage term
  - Driven by bldg operations, weather variation

- **Energy Price**
  - $/kWh, $/kW, $/therm
  - Set by rate structure

- **Energy Price Volatility**
  - +/- change over mortgage term
  - Driven by rate structure, forward price curves

Current practice does not fully account for these factors in calculation of Net Operating Income (NOI)

- Usually based on historical average cost data, if available
- Does not account for energy use and price volatility during mortgage term

**Key question:** How much do these factors “move the needle” for NOI and default risk?
Approach: Impact of energy on default rate

Mortgage Default Rate = \( f (\text{EUI}, \text{ElecPriceGap}, \text{CouponSpread}, \text{LTV}, \text{Region}) \)

Empirical analysis combining
- Mortgage loan data (TREPP)
- Energy use data (Benchmarking disclosure)
Default risk and source EUI: Office and Retail – Linear probability model

<table>
<thead>
<tr>
<th></th>
<th>Coefficient Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.40444**</td>
<td>0.18466</td>
</tr>
<tr>
<td>Log Source EUI</td>
<td>0.07335**</td>
<td>0.03129</td>
</tr>
<tr>
<td>Origination Loan-to-Value Ratio</td>
<td>0.00258***</td>
<td>0.00096</td>
</tr>
<tr>
<td>Coupon Spread to 10 Year Treasury</td>
<td>0.02188</td>
<td>0.01565</td>
</tr>
<tr>
<td>Electricity Price Gap</td>
<td>0.00003***</td>
<td>0.00001</td>
</tr>
<tr>
<td>Time to Maturity on Balloon</td>
<td>-0.00189***</td>
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<td>Origination Year Fixed Effects</td>
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<tr>
<td>N = 473</td>
<td></td>
<td>R2 = .1052</td>
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</table>

* p<0.1; ** p<0.05; ***p<0.01
The coefficient estimates for **BOTH** the *Electricity Price Gap* and *Source EUI* are significant at better than the .05 level of statistical significance.

**Both** coefficient estimates are also economically meaningful:

- The higher the *Source EUI* (the more energy usage per square foot) the higher the likelihood of default.
- The higher the *Electricity Price Gap*, (the larger the difference between the actual and the expected electricity prices since the loan origination), the higher the likelihood of default.
What are the impacts on specific cases? – Scenario analysis

- Develop range of scenarios that have different energy factor risks
  - Range of locations, building features, operations, etc.

For each scenario:
- Determine energy consumption and price volatility.
  - Use combination of empirical and simulation approaches
- Use hazard model coefficients to determine impact on default risk
<table>
<thead>
<tr>
<th>Use</th>
<th>Size</th>
<th>Climate</th>
<th>Asset eff</th>
<th>ASHRAE 90.1 (approx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>500,000</td>
<td>4A (Baltimore)</td>
<td>High</td>
<td>2013</td>
</tr>
<tr>
<td>Office</td>
<td>500,000</td>
<td>4A (Baltimore)</td>
<td>Medium</td>
<td>2004</td>
</tr>
<tr>
<td>Office</td>
<td>500,000</td>
<td>4A (Baltimore)</td>
<td>Low</td>
<td>2004 w/ pre-1980 env.</td>
</tr>
<tr>
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<td>2A (Houston)</td>
<td>High</td>
<td>2013</td>
</tr>
<tr>
<td>Office</td>
<td>500,000</td>
<td>2A (Houston)</td>
<td>Medium</td>
<td>2004</td>
</tr>
<tr>
<td>Office</td>
<td>500,000</td>
<td>2A (Houston)</td>
<td>Low</td>
<td>2004 w/ pre-1980 env.</td>
</tr>
<tr>
<td>Office</td>
<td>200,000</td>
<td>4A (Baltimore)</td>
<td>Medium</td>
<td>2004</td>
</tr>
<tr>
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<td>25,000</td>
<td>4A (Baltimore)</td>
<td>Medium</td>
<td>2004</td>
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</table>

...
A wide range of operational factors affect year-to-year energy use variations

<table>
<thead>
<tr>
<th>Facilities management</th>
<th>Occupant behavior</th>
<th>Maintenance</th>
</tr>
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<tbody>
<tr>
<td>1. Economizer settings</td>
<td>1. Lighting controls</td>
<td>1. Damper/valve check</td>
</tr>
<tr>
<td>2. VAV box minimum flow setting</td>
<td>2. Window operation</td>
<td>2. Filter change</td>
</tr>
<tr>
<td>4. Static pressure reset</td>
<td>4. Local heating/cooling equipment</td>
<td>4. ...</td>
</tr>
<tr>
<td>5. Chilled water/Hot water supply temperature reset</td>
<td>5. Plug in equipment</td>
<td>5. ...</td>
</tr>
<tr>
<td>6. Condenser water temperature reset</td>
<td>6. ...</td>
<td>6. ...</td>
</tr>
<tr>
<td>7. Chiller/boiler sequencing</td>
<td>7. ...</td>
<td>7. ...</td>
</tr>
<tr>
<td>8. ...</td>
<td>8. ...</td>
<td>8. ...</td>
</tr>
</tbody>
</table>

**Weather**

Vacancy rates
### Range of practice for each operation factor

<table>
<thead>
<tr>
<th>Factor</th>
<th>Good practice</th>
<th>Average practice</th>
<th>Poor practice</th>
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</thead>
<tbody>
<tr>
<td>Lighting controls</td>
<td>Daylight-dimming + occ</td>
<td>Occ only</td>
<td>Timer only</td>
</tr>
<tr>
<td>Plug load controls</td>
<td>Turn off when occupants leave</td>
<td>Sleep mode by itself</td>
<td>No energy saving measures</td>
</tr>
<tr>
<td>HVAC schedule</td>
<td>optimal start</td>
<td>2hr +/- Occupanct sch</td>
<td>n/a</td>
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<tr>
<td>Thermostat settings</td>
<td>68°F for heating and 78°F for cooling Setback: 60 - 85</td>
<td>70°F for heating and 76°F for cooling Setback: 68 - 80</td>
<td>72°F for heating and 74°F for cooling No setback</td>
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<tr>
<td>Supply air temp reset</td>
<td>SAT reset base on warmest zones</td>
<td>SAT reset based on the stepwise function of outdoor air temperature</td>
<td>Constant supply air temperature</td>
</tr>
<tr>
<td>VAV box min flow settings</td>
<td>15% of design flow rate.</td>
<td>30% of design flow rate.</td>
<td>50% of design flow rate.</td>
</tr>
<tr>
<td>Economizer controls</td>
<td>Enthalpy</td>
<td>dry bulb</td>
<td>none/broken</td>
</tr>
<tr>
<td>Chilled water supply temp reset</td>
<td>Reset chilled water temperature based on cooling demand.</td>
<td>Linear relationship with outside air temp (OAT).</td>
<td>No reset with constant year-round.</td>
</tr>
<tr>
<td>Chiller sequencing</td>
<td>Kick on the lag chiller when the lead chiller reaches its peak efficiency.</td>
<td>Kick on the lag chiller when the chilled water temperature cannot be maintained.</td>
<td>Always running two chillers</td>
</tr>
<tr>
<td>Hot water supply temp reset</td>
<td>Reset the hot water supply temperature according to heating load.</td>
<td>Linear relationship with OAT.</td>
<td>No reset with constant year-round.</td>
</tr>
<tr>
<td>Boiler sequencing</td>
<td>Kick on the lag boiler when lead boiler reaches its peak efficiency.</td>
<td>Kick on the second boiler based on OAT.</td>
<td>No sequencing and always running two boilers.</td>
</tr>
<tr>
<td>Plug load intensity</td>
<td>0.4 W/sf</td>
<td>0.75 W/sf</td>
<td>2.0W/sf</td>
</tr>
<tr>
<td>Occupant density</td>
<td>400 sf/per</td>
<td>200 sf/per</td>
<td>130 sf/per</td>
</tr>
<tr>
<td>Occupant schedule</td>
<td>8 hour WD</td>
<td>12 Hr WD</td>
<td>16 Hr WD</td>
</tr>
</tbody>
</table>
Range of variation due to operation factors
## Impact on default risk – scenario analysis

<table>
<thead>
<tr>
<th>Case</th>
<th>Source EUI change from basecase (%)</th>
<th>Source EUI (kBtu/sf.yr)</th>
<th>Default risk change (basis points)</th>
<th>Default risk change from TREPP avg (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A Baseline</td>
<td>-</td>
<td>172</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2A Poor practice</td>
<td>+32.5%</td>
<td>228</td>
<td>+90</td>
<td>+11.2%</td>
</tr>
<tr>
<td>2A Good practice</td>
<td>-16.5%</td>
<td>144</td>
<td>-57</td>
<td>-7.2%</td>
</tr>
<tr>
<td>2A Low asset efficiency</td>
<td>+0.8%</td>
<td>173</td>
<td>+3</td>
<td>+0.3%</td>
</tr>
<tr>
<td>2A High asset efficiency</td>
<td>-20.3%</td>
<td>137</td>
<td>-72</td>
<td>-9.0%</td>
</tr>
<tr>
<td>2A Weather 2001-15 high</td>
<td>+1.4%</td>
<td>174</td>
<td>+4</td>
<td>+0.6%</td>
</tr>
<tr>
<td>4A Baseline</td>
<td>-</td>
<td>169</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4A Poor practice</td>
<td>+41.7%</td>
<td>239</td>
<td>+111</td>
<td>+13.9%</td>
</tr>
<tr>
<td>4A Good practice</td>
<td>-12.2%</td>
<td>148</td>
<td>-41</td>
<td>-5.2%</td>
</tr>
<tr>
<td>4A Low asset efficiency</td>
<td>+2.1%</td>
<td>173</td>
<td>+7</td>
<td>+0.8%</td>
</tr>
<tr>
<td>4A High asset efficiency</td>
<td>-15.6%</td>
<td>143</td>
<td>-54</td>
<td>-6.7%</td>
</tr>
<tr>
<td>4A Weather 2001-15 high</td>
<td>+0.8%</td>
<td>170</td>
<td>+3</td>
<td>+0.3%</td>
</tr>
</tbody>
</table>
Pilot projects

Collaborate with lenders to:
1. Demonstrate impact of energy use and price on specific mortgage loans
2. Develop recommendations

Approach
- Compile info from Appraisals, PCAs, other sources.
- Estimate source EUI variations.
  - Simulation and empirical approaches
- Compute elec price gap using forward curves.
- Compute default risk impact due to source EUI and elec price gap.
- Publish pilot case study and recommendations.
Small office pilot: Energy use and default risk

Facilities Management factors:
- HVAC schedule
- Thermostat setback
- Supply air temp control
- VAV min flow control
- Economizer controls
- Lighting controls
*Levels: good, avg, poor*

Occupancy factors:
- Occupant density
- Occupant schedule
- Plug load density
- Plug load controls
*Levels: good/low, avg, poor/high*

### Preliminary results

<table>
<thead>
<tr>
<th>Case</th>
<th>Fac mgmt factors Level</th>
<th>Occ Factors Level</th>
<th>Source EUI change (%)</th>
<th>Default risk change (bp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Good</td>
<td>Good/Low</td>
<td>-54%</td>
<td>-248</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>Ave</td>
<td>-33%</td>
<td>-127</td>
</tr>
<tr>
<td>3</td>
<td>Ave</td>
<td>Ave</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>Poor/High</td>
<td>+4%</td>
<td>+12</td>
</tr>
<tr>
<td>5</td>
<td>Poor</td>
<td>Good/Low</td>
<td>+64%</td>
<td>+158</td>
</tr>
<tr>
<td>6</td>
<td>Poor</td>
<td>Ave</td>
<td>+76%</td>
<td>+181</td>
</tr>
<tr>
<td>7</td>
<td>Poor</td>
<td>Poor/High</td>
<td>+132%</td>
<td>+268</td>
</tr>
</tbody>
</table>
Small office pilot:
Energy price and default risk

**preliminary results**

1 std deviation from 0: 
+/- 3.3% (330 bp)
Looking ahead

**Vision:**
*Energy factors are fully and routinely incorporated in commercial mortgage valuation, accelerating demand for buildings with lower energy risk.*

- **Year 1:** Analysis of energy impacts on mortgage valuation
- **Year 2:** Pilot case studies on actual mortgage loans
- **Year 3:** Best practices protocols for lenders and owners
- **Long term:** Industry Standards
Actions you can take NOW

**Lenders:**
- Ask owners to provide information about energy cost risks.
  - Could be done as part of Property Condition Assessment

**Owners:**
- Ask lenders to account for energy efficiency when setting mortgage terms.
- Provide data on energy costs to lender.
  - Historical and anticipated
  - In appraisal and/or PCA

*Please let us know if you would like to participate in this project!*
Acknowledgements

- Holly Carr (U.S. DOE)
- Cindy Zhu (U.S. DOE)
- Philip Coleman (LBNL)
- Jeff Deason (LBNL)
- Tianzhen Hong (LBNL)
- Paulo Issler (UCB)
- Leonard Kolstad (IMT)
- Bob Sahadi (IMT)
- Kaiyu Sun (LBNL)
Appraising Green Buildings

Andrew White
JDM Associates
BUILDING SUSTAINABILITY

WE ARE DEDICATED PROFESSIONALS THAT STRIVE TO IMPROVE THE PERFORMANCE OF BUILDINGS — CREATING VALUE THROUGH ENERGY & RESOURCE MANAGEMENT, REAL ESTATE STRATEGY, AND CRAFTING TRANSFORMATIONAL PROGRAMS FOR OUR CLIENTS.
The Appraisal Process

1. Identify the Need for Appraisal and Valuation
2. Define Scope of Work
3. Collect Property Data and Information
4. Analyze Property Data and Information
5. Apply Approaches to Value
6. Reconcile Value and Provide Final Opinion
7. Submit final report
Barriers

- Regulatory and market changes that increase *commoditization* of appraisals
  - Little budget or reward for making “unusual” adjustments, even when warranted
  - Fragmented, aging, and skeptical appraisal workforce
  - Lack of confidence in addressing green buildings

- Poor *communication* of high-performance building features amongst owners, lenders, and appraisers

- Lack of relevant *education*, training, and energy-related knowledge amongst appraisers
Appraisal Industry by the Numbers

- Appraisers in the U.S.: 60,000
- Estimated commercial appraisers: 12,000
- Annual reduction in total workforce: 3%
- Appraisers over 50 years old: 62%
- Appraisers who are sole proprietors: 62%
- Appraisers not belonging to any professional association: 66%
Commercial Real Estate:
- CB Richard Ellis
- Colliers International
- Connecticut Green Bank
- Cushman & Wakefield
- Fannie Mae
- GRESB
- Home Innovation Research Labs
- Inspyrod
- Institute for Market Transformation (IMT)
- LaSalle Investment Management
- Lawrence Berkeley National Laboratory (LBL)
- MetLife
- PNC
- Security National Mortgage Company
- US EPA (ENERGY STAR)
- USGBC
- View Glass

Appraisal Industry:
- Akerson & Wiley

- DeLacy Consulting
- Earth Advantage
- Runde & Partners, Inc.
- Sustainable Values, Inc.
- The Appraisal Foundation (TAF)
- The Appraisal Institute (AI)
The Appraisal Process

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Working Group Accomplishments

- **Sample Scope of Work Language for Appraisers Valuing High Performance and Energy Efficient Buildings**
- Online [Appraisal Toolkit](#) with tools, resources, and other information related to appraising green buildings
- Developed appraisal questions for the 2017 [GRESB Debt Survey](#)
- Upcoming: TAF APB Valuation Advisory for Green Commercial, Multifamily and Institutional Properties
• Large, influential owners
• Voluntary collaboration to address energy in the appraisal process
• Coordinating with Altus Group to revise scoping agreements
• Proposing greater emphasis on green and high-performance features during valuation
• Potential pilots to be conducted later in 2017
• Emphasis on applying outputs from three federal tools:
  • ENERGY STAR Portfolio Manager
  • Building Energy Asset Score
  • Building Performance Database

• Designed to build upon existing resources, and fill gaps in current trainings
• Conducted live pilots
• Applied for IDECC online certification
Next Steps

• Promote toolkit and resources

• Engage GRESB to include appraisal questions on Equity Assessment

• Continue working with NAREIM ODCE index members to exert influence over appraisal communications and templates
  • Conduct pilot appraisals that incorporate new resources and emphasize valuation of green and high-performance building features

• Achieve IDECC certification for *Energy Matters!* and promote the training to appraisers

• Continue outreach and engagement efforts with lenders
Discussion

- Do you currently consider energy efficiency in your mortgages?
  - If yes, how?
  - If not, why not?

- What are the opportunities and barriers to applying these actions in your organization?
  - Who are key stakeholders needing buy-in?
  - How can DOE help?
Contact Us

**Paul Mathew**
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nawallace@berkeley.edu

**Andrew White**
JDM Associates
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Thank You

Provide feedback on this session in the new Summit App!

Download the app to your mobile device or go to bbsummit.pathable.com
Ideal analysis approach

- **Analysis on an empirical data set that has:**
  - Time-variant data on energy factors for specific buildings
  - Loan performance data for the same buildings
  - A representative sample across different market segments

- **Challenges:**
  - *Lack of time-variant consumption dataset that can be matched with loan data*
  - *Lack of tariff data for individual buildings*
Energy price gap

- Proxy for total unexpected energy expenditures
- Computed by summing monthly deviations of realized electricity prices from expected electricity prices at the time of mortgage origination
- Energy price gap, at time $t$, for a commercial mortgage originated at a time period $t_0$ within ISO zone $k$:

$$pgap_k(t_0,t) = \sum_{s=t_0}^{s=t} lmp_k(s) - hlmp_{k,month}(s)(t_0)$$

- Where:
  - $lmp = $ monthly average on-peak locational marginal electricity price
  - $hlmp = $ historical monthly average locational marginal price observed at the mortgage origination date.
Energy price gap

- Example: Evaluating the Energy Price Gap 22 months after the mortgage origination
Default risk and site EUI: Office and retail – linear prob. model

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<td>0.07404</td>
<td>-0.10734</td>
<td>0.08375</td>
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<tr>
<td>Log Site EUI</td>
<td>0.03169*</td>
<td>0.01711</td>
<td>0.02685</td>
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<tr>
<td>Origination Loan-to-Value Ratio</td>
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<td></td>
<td>0.0015**</td>
<td>0.00034</td>
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<tr>
<td>Coupon Spread to 10 Year Treasury</td>
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<td></td>
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<td>0.00014</td>
</tr>
<tr>
<td>Electricity Price Gap</td>
<td></td>
<td></td>
<td>0.00002***</td>
<td>0.00000</td>
</tr>
<tr>
<td>Time to Maturity on Balloon</td>
<td></td>
<td></td>
<td>-0.00048*</td>
<td>0.00028</td>
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<td>Origination Year Fixed Effects/Year Fixed Effects</td>
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<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>N = 535</td>
<td></td>
<td></td>
<td>N = 516</td>
<td></td>
</tr>
<tr>
<td>R2 = .002</td>
<td></td>
<td></td>
<td>R2 = .0701</td>
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</tbody>
</table>

* p<0.1; ** p<0.05; ***p<0.01
Default risk and site EUI: Office and retail – linear prob. model

- \textit{Site EUI} is not statistically significantly different from 0 at better than .05 level.
- Electricity Price Gap is significant at better than the .05 level of statistical significance.
- Both coefficients have economically meaningful signs:
  - The higher the \textit{Site EUI} (the more energy usage per square foot) the higher the likelihood of default.
  - The higher the \textit{Electricity Price Gap}, (the larger the difference between the realized and the expected electricity prices since the loan origination), the higher the likelihood of default.
# Default risk and ENERGY STAR Score: Office and retail – linear prob. model

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<tr>
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<td>0.00079</td>
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<tr>
<td>Origination Loan-to-Value Ratio</td>
<td>0.00183*</td>
<td>0.00099</td>
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<td>Electricity Price Gap</td>
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<td>Time to Maturity on Balloon</td>
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<td>Origination Year Fixed Effects/Year Fixed Effects</td>
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<td>Yes</td>
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<tr>
<td>N = 448</td>
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<td>N = 432</td>
<td>R2 = .071</td>
</tr>
</tbody>
</table>

* p<0.1; ** p<0.05; ***p<0.01
Default risk and ENERGY STAR score: Office and Retail – Linear Prob. Model

- **Energy Star Score** is not statistically significantly different from 0 at better than .05 level.
- Electricity Price Gap is significant at better than the .05 level of statistical significance.
- Both coefficients have economically meaningful signs:
  - The higher the **Energy Star Score** (the more energy efficient the building) the lower the likelihood of default.
  - The higher the **Electricity Price Gap**, (the larger the difference between the realized and the expected electricity prices since the loan origination), the higher the likelihood of default.
Range of variation due to weather: 2001-2015